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Rough surface mitigates electron and gas emission

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Rough surface mitigates electron and gas emission

Heavy-ion beams impinging on surfaces near grazing incidence (to simulate the loss of halo ions) generate copious amounts of electrons and gas that can degrade the beam. We measured emission coefficients of $\eta_e \leq 130$ and $\eta_0 \approx 10^4$ respectively, with 1 MeV K^+ incident on stainless steel. Electron emission scales as $\eta_e \propto 1/\cos(\theta)$, where θ is the ion angle of incidence relative to normal. If we were to roughen a surface by blasting it with glass beads, then ions that were near grazing incidence (90°) on smooth surface would strike the rims of the micro-craters at angles closer to normal incidence. This should reduce the electron emission: the factor of 10 reduction, Fig. 1(a), implies an average angle of incidence of 62°. Gas desorption varies more slowly with θ (Fig. 1(b)) decreasing a factor of ~2, and along with the electron emission is independent of the angle of incidence on a rough surface.

In a quadrupole magnet, electrons emitted by lost primary ions are trapped near the wall by the magnetic field, but grazing incidence ions can backscatter and strike the wall a second time at an azimuth where magnetic field lines intercept the beam. Then, electrons can exist throughout the beam (see the simulations of Cohen, HIF News 1-2/04). The SRIM (TRIM) Monte Carlo code predicts that 60-70% of 1 MeV K^+ ions backscatter when incident at 88-89° from normal on a smooth surface. The scattered ions are mostly within ~10° of the initial direction but a few scatter by up to 90°. Ion scattering decreases rapidly away from grazing incidence, Fig. 1(c). At 62 deg. the predicted ion backscattering (from a rough surface) is 3%, down a factor of 20 from the peak, which should significantly reduce electrons in the beam from lost halo ions. These results are published in Phys. Rev. ST – Accelerators and Beams. – *Art Molvik*

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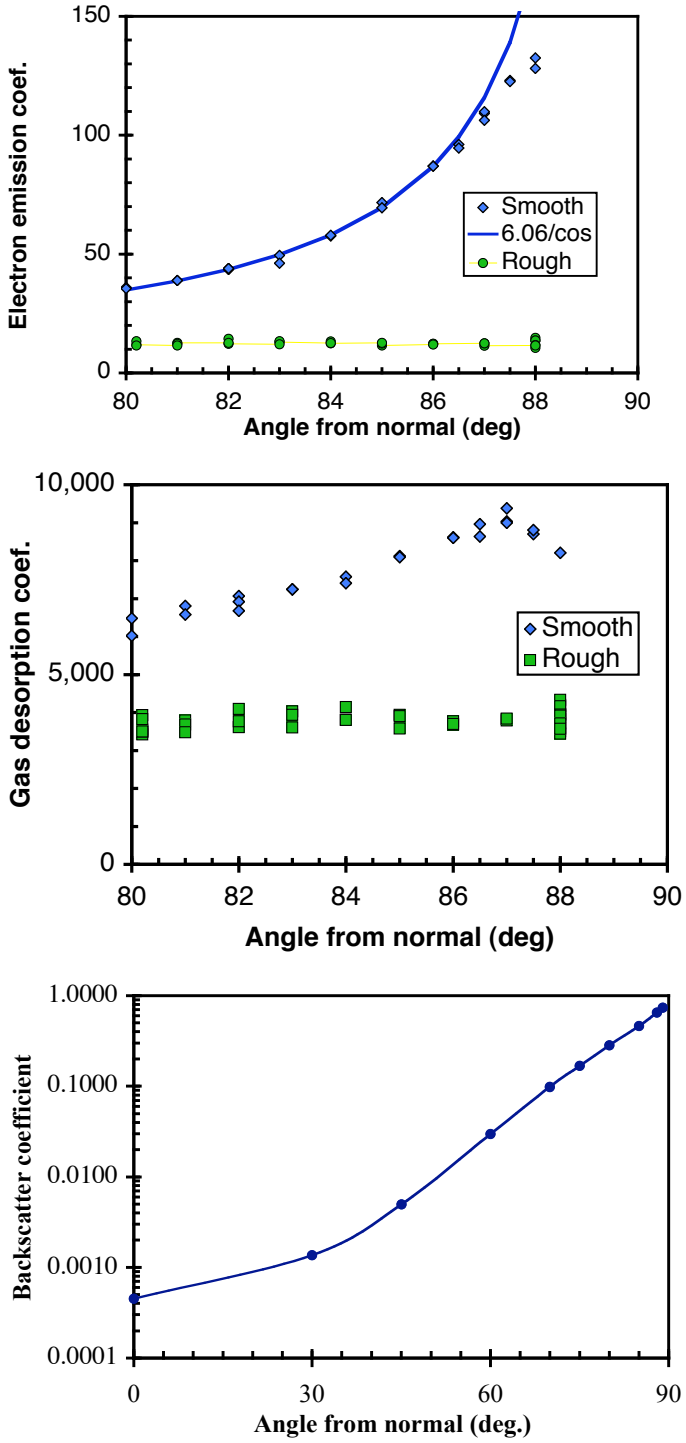

Fig. 1. (a) Electron emission coefficient, (b) Gas desorption coefficient, (c) Ion backscatter from a smooth surface, as predicted by the SRIM code.